DIVISION 15 – MECHANICAL

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SECTION 15010 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DOCUMENTS

A. The provisions, terms and requirements of Instruction to Bidders, General Conditions, and Supplementary Conditions and the Applicable Drawings and Technical Specifications herein apply to work under this Division.

B. Drawings are partly diagrammatic, and do not necessarily show the exact location of piping and ductwork.

C. Risers and other diagrams are schematic only, not to scale, and do not necessarily show the physical arrangement of the equipment. Do not use riser diagrams to obtain lineal runs.

D. Specifications are of the abbreviated or "streamlined" type and include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "in conformity with", "shall be", etc., are intentional. Omitted words or phrases shall be supplied by inference.

1.2 SCOPE

A. This work consists of, but is not necessarily limited to, the furnishing of all plant, labor, equipment, appliances and materials and the performance of all operations in connection with the installation of all mechanical work complete, in strict accordance with specifications and/or drawings, including incidentals necessary and required for their completion.

B. Note alternates listed and account for any change in the work and include any price deemed necessary to meet the requirements of the respective alternate. See General Requirements for Schedule of Alternates.

1.3 WORKMANSHIP

A. Workmanship shall be by workers skilled in particular trade in conformance with best practices.

B. Work shall contribute to efficiency of operation, access, maintenance, appearance. No part of installation shall interfere with operation of any other system or parts of building.

C. Materials or equipment not properly installed or finished shall be repaired or replaced as hereinafter provided under Guaranty-Warranty.

D. Guaranty-Warranty - See General Conditions for work under this Section, and mechanical sections within where special warranty conditions are noted.

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for installation of satisfactory and complete piece of work in accordance with intent of drawings and specifications, providing all incidental items required for completion of work whether or not specifically mentioned or indicated.

B. Consult all drawings for project, shop drawings of other trades, and verify building dimensions to predetermine that work and equipment will fit as intended.

C. Check location of piping, ducts, equipment, etc., to verify clearance from all openings, structural members, cabinets, lights, outlets, equipment having fixed locations, etc., and proper concealment above, behind or within finished surfaces. Coordinate with Electrical Contractor; maintain clearance required by NEC from electrical panels.

D. Changes in the location of pipes, ducts, equipment, etc., necessary due to obstacles or work of other trades shall be made only after approved by Engineer.

E. Prior to submitting bid, visit site of project and ascertain conditions affecting proposed work and make allowances as to cost thereof.

1.5 COORDINATION

A. Coordinate the work to proceed with minimum interference with other trades.

B. Inform General Contractor of all openings required in building structure for installation of work.

C. Check all dimensions of equipment installed or provided by others so correct clearance and connections can be made.

D. Electrical wiring diagrams and instructions shall be provided in ample time so equipment can be properly wired.

1.6 PROJECT CONDITIONS OR SITE CONDITIONS

A. Permits and Testing
1. The Contractor shall pay for all permits or fees in connection with the Work.

B. Temporary Water and Heat
1. See Specifications Group, General Requirements Subgroup.
2. Contractors must maintain existing HVAC equipment throughout construction.
   a. Revise filtration media at thirty (30) day intervals in construction areas, or as directed by Engineer.
3. Ventilation system shall remain in operation throughout construction. System change-overs must be scheduled and be of minimum duration. Max duration 4 hours.

C. Existing Conditions
1. The work shall be coordinated with existing conditions.
2. Prior to submitting bid, visit site of project and ascertain conditions affecting proposed work and make allowances as to cost thereof.

D. Remodeling
1. Construction operations will coincide with the Owner's continued occupancy and use of the building.
2. Connections and work within existing building shall be performed with minimum inconvenience to Owner.
3. Whenever existing systems (plumbing, heating, service lines, piping, ducts, controls, etc.,) are cut into, removed or interrupted as a result of the contract work, they shall be replaced, repaired, rerouted, extended or relocated as necessary to maintain operation of equipment and serve areas that remain.

PART 2 - PRODUCTS

2.1 REMODELING

A. All Materials used shall be as specified under Division 15.

B. Existing system branch piping shall be capped with like materials and methods in complete accord with IMC.

PART 3 - EXECUTION

3.1 OPENINGS

A. Openings in pipes and ducts shall be kept closed during progress of work. Clean systems found dirty to satisfaction of Engineer and at no additional cost.

3.2 CUTTING, PATCHING AND FRAMING

A. Chases, openings, sleeves, hangers, anchors, recesses, equipment, pads, framing for equipment, are provided by others only as shown on Architectural or Structural Plans. If not shown on Architectural or Structural Plans, they are provided by the Mechanical Contractor for his work.

B. Mechanical Contractor shall be responsible for correct size and locations of chases, equipment pads, curbs, etc., whether provided by Mechanical Contractor or others.

C. Cutting of structural members is not permitted without consent of Engineer or Structural Engineer and under supervision of General Contractor.

D. Mechanical cutting and patching that is required for the installation of work is the responsibility of the Mechanical Contractor but done only by the General Contractor in finished work.

3.3 ACCESS AND CLEARANCE

A. Provide access and clearance to valves, coils, dampers, equipment and items requiring service; including access doors through ceilings and walls where required. All required access doors are not indicated on the drawings but are required to be provided by MC. Location of doors shall be coordinated with the Engineer prior to installation.

3.4 PAINTING

A. Mechanical equipment shall be provided with standard finish and color; except that if manufacturer has no standard finish, equipment must have prime coat of paint. Note exceptions where specific finish or color or choice is specified.

END OF SECTION 15010

SECTION 15015 - LOCAL CONDITIONS

PART 1 - GENERAL

1.1 PERMITS AND TESTING

A. The Contractor shall pay for all permits or fees in connection with the work.

B. Any system development fees shall be paid by the Owner.

1.2 CODES AND STANDARDS

A. All work shall be in accordance with applicable local, state, and national codes and ordinances; including, but not limited to the latest legally enacted editions of the following:

B. International Building Code (IBC)
International Fire Code (IFC)
International Mechanical Code (IMC)
Uniform Plumbing Code (UPC)
National Electrical Code (NEC)

C. The following references infer that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
American National Standards Institute (ANSI)
American Sanitary Association (ASA)
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
American Society of Mechanical Engineers (ASME).
American Society for Testing and Materials (ASTM)
National Fire Protection Association (NFPA)
National Sanitation Foundation (NSF)
Sheet Metal and Air Conditioning National Contractors Association (SMACNA)
Underwriters Laboratories, Inc. (UL)
Factory Mutual (FM)

1.3 ALTERATIONS

A. Changes or revisions may be made to suit job conditions if such changes meet local codes and make for an equal or better job. Review such modifications with Engineer prior to implementation.

PART 2 – PRODUCTS Not applicable

PART 3 – EXECUTION

3.1 CLEAN-UP

A. Clean labels, stains, etc. from equipment.

B. Clean equipment of dirt and debris including interior of heating units, ducts, drains, piping and fans.

C. Upon completion of work, remove materials, scraps, etc., related to the work and leave premises, including all tunnels, attics, ceilings and crawl spaces in clean and orderly conditions.

END OF SECTION 15015

SECTION 15020 - MATERIALS

PART 1 - GENERAL

1.1 SUBSTITUTION OF MATERIALS

A. See Division 1, General Requirements

B. Except where noted as "equivalents acceptable" or "or equal", material or equipment specifically identified by manufacturer's name, model, or catalog number are open for substitution prior to bid opening only.
   1. To be considered, requests for approval must;
      a. Be originals, sent by mail or delivery, accompanied by the Substitution Request Form. **Requests will NOT be accepted by FAX.**
      b. Include, in duplicate, manufacturer's descriptive literature and technical data sufficient to enable evaluation of equivalence to specified materials.
      c. Be received no less than seven (7) calendar days prior to the date set for the bid opening.
   2. If written verification of approval/disapproval is desired, a self-addressed, stamped envelope must be included.
   3. No approval is considered final until listed in an addendum to the contract documents.

C. Where substituted equipment requires ductwork, piping or electrical work differing from the basic design, the cost of all changes, including re-design, is the responsibility of the Contractor using the equipment.

1.2 RESPONSIBILITIES

A. Provide for delivery and storage of required materials. Store equipment and materials such that they are protected, easily checked and inspected.

B. Arrange with General Contractor for introduction of equipment too large to pass through finished openings.

C. Protect materials and equipment installed under this Contract and protect materials and equipment of others from damage as result of this work.

D. Material and equipment shall be installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified otherwise.

1.3 SUBMITTALS

A. See Division 1, General Requirements.

B. Within thirty (30) days of the award of Contract the prime Mechanical Contractor shall provide Submittals for the materials to be provided. Submittals for each portion of work (i.e. plumbing fixtures, heating units, air distribution equipment, temperature controls, etc.) shall be bound in booklet form with all items in order consistent with specifications and/or schedules.

C. To be reviewed each submittal must:
   1. Be originals sent by mail or deliver, with transmittal letter identifying specifications section for material submitted. **Submittals will NOT be accepted by FAX.**
   2. Have Contractor's signature on one (1) copy minimum attesting to the correctness and compliance of the Submittal. Submittals shall be marked with date.
   3. Include Shop Drawings detailing any engineering changes necessary to implement installation of substituted materials.

D. Product Data shall include manufacturer's literature indicating manufacturer, specific items used, sizes, dimensions, capacities, rough-in requirements, installation, maintenance, lubrication, operating instructions, and wiring diagrams.

E. Shop Drawings shall provide complete details of the proposed layout and installation of equipment and systems as specifically required for this project.

F. Submittals for equipment items crucial to the schedule of construction shall include estimated delivery schedules.

G. Provide enough copies for job use and distribution. Engineer will retain two (2) copies. One reviewed copy of all operating equipment to be tested shall be provided to the Testing and Balancing Subcontractor.

H. Submittals marked "Revise and Resubmit" shall be changed and resubmitted until correct and/or complete enough for review. Resubmittals shall be properly marked with date.

I. Review of Submittals shall not relieve Contractor from responsibility for deviations from drawings, or specifications unless he has in writing called Architect's or Engineer's attention to such deviations and secured his written acknowledgment, nor shall it relieve him from responsibility for errors in Submittals or literature.

J. Schedule:

SUBMITTAL SCHEDULE

SPEC. SECTION	MECHANICAL MATERIAL DESCRIPTION	PROD DATA	SHOP DRWG	IO&M BOOK	WIRE DIAG
15030	Firestopping	X	X	X	
15060	Hangers and Supports	X			
15075	Pipe, Valves, Equip. ID	X	X		
15080	Mechanical Insulation	X	X		
15095	Access Doors	X	X		

SUBMITTAL SCHEDULE					
SPEC. SECTION	MECHANICAL MATERIAL DESCRIPTION	PROD DATA	SHOP DRWG	IO&M BOOK	WIRE DIAG
15100	Pipe and Fittings	X	X		
15110	Manual Valves	X	X		
15115	Control Valves	X	X	X	
15120	Pipe Specialties	X	X	X	
15130	Pumps with Curves	X	X	X	X
15180	Heating & Cooling Piping Specialties	X	X	X	
	Water Source Heat Pumps	X	X	X	X
15900	Energy Management & Control Systems	X	X	X	X
15945	Variable Speed Drives	X	X	X	X

END OF SECTION 15020

SECTION 15030 - FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes firestopping for penetration seals of all mechanical system openings in fire rated floors, walls and assemblies, and smoke barriers, to ensure an effective barrier of the required rating.

B. Related Work:
1. Section 16030 Firestopping
2. UL Assembly number of fire and smoke rated assemblies shall be as specified or indicated on the general construction drawings.

1.2 SYSTEM DESCRIPTION

A. Firestopping materials and systems must fill openings in fire resistive assemblies created by penetrating mechanical systems and must be capable of closing or filling through-openings created by the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials; or deflection of pipes or sheet metal due to thermal expansion.

B. Firestopping systems shall resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E 119 Method of Fire Tests of Building Construction and Materials
3. ASTM E 814 Test Method for Fire Tests of Through-Penetration

B. Underwriters Laboratory, Inc. (UL):
1. UL 723 Surface Burning Characteristics of Building Materials
2. UL 1479 Fire Tests of Through-Penetration Firestops
3. UL 2079 Test for Fire Resistance of Building Joint Systems
4. UL Fire Resistance Directory
5. UL Building Materials Directory.

1.4 SUBMITTALS

A. Product Data: Manufacturer’s literature for each type of firestopping material indicating product characteristics, typical uses, performance and limitation criteria, and test data.

B. Shop Drawings: Manufacturer's detail drawing of each type of penetration indicating UL Tested System number, and all installation requirements.

C. Warranty: Submit written guarantee for repair or replacement of systems which fail in any manner not clearly specified by manufacturer's submitted data as an inherent quality of the

material for the exposure indicated. The guarantee period shall be one year from date of substantial completion.

1.5 QUALITY ASSURANCE

A. Materials shall be UL listed, compliant with applicable codes, and tested in accordance with test methods as follows:
   1. Surface Burning Characteristics: ASTM E 84
   2. Fire Resistance Ratings: ASTM E 119
   3. Combustion Characteristics: ASTM 136
   4. Through Penetration Rating: ASTM E 814

B. Materials shall have ratings less than flame spread of 25 and smoke developed of 50 as determined in accordance with ASTM E 84.

C. Comply with product specific requirements for storage, handling, area usage, electronic interference, and exposure. Maintain identification labels on materials in use or storage.

D. Copies of submittals shall be kept on site and accessible to Inspectors for the Authority Having Jurisdiction, the Architect/Engineer, and designated Owner's Representatives.

E. Qualifications
   1. Installation shall be performed by craftsman trained to perform the work of this section.
   2. Installation shall be performed by a firestopping subcontractor whose personnel have received specialized training and certification or approval from the proposed fire-stopping manufacturer. Subcontractor shall have a minimum of three years' experience installing firestopping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equivalent products of Enerstop Systems, Hilti Systems, Johns Manville, U.S.G., RectorSeal, STI and 3M are acceptable.

2.2 REQUIREMENTS

A. Firestopping materials shall be free of asbestos and lead and shall not incorporate nor require the use of hazardous solvents.

B. Firestopping materials must be flexible, allowing for normal pipe movement or sheet metal deflection.

C. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.

D. Firestopping materials shall be moisture resistant and may not dissolve in water after curing.

E. Firestopping materials shall be UL rated for assembly indicated as determined in accordance with UL listings.

2.3 DESCRIPTION

A. Materials may include:
   1. Intumescent Sealants and Caulks
   2. Latex Sealant
   3. Elastomeric Water Based Sealant
   4. Silicone Sealants and Caulks
   5. Moldable Putty
   6. Collars
   7. Wrap Strips
   8. 2-Part Silicone Foam
   9. Firestopping Mortar
   10. Firestopping Pillows
   11. Elastomeric Spray
   12. Intumescent Spray Mastic
   13. Endothermic Spray Mastic
   14. Forming/Damming Materials

B. Intumescent material shall be capable of expanding up to 10 times when exposed to temperatures beginning at 250 deg. F. Material shall have approved ratings to 4 hours per ASTM E 814 (UL 1479).

PART 3 - EXECUTION

3.1 GENERAL

A. Verify the location, rating and appropriate construction of all fire or smoke rated assemblies as indicated on the architectural drawings.

B. Install in all open penetrations and in the annular space in all through-penetrations in any bearing or non-bearing fire or smoke rated barrier.

C. Install in all penetrations of the membrane of rated walls, floors or ceilings.

3.2 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and the manufacturer's instructions.

B. Provide metal wrap on all insulated pipe and polybutylene pipe.

C. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.

D. Protect materials from damage on surfaces subject to traffic.

E. Damming or packing materials shall be used when required to properly contain firestopping materials within openings. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestopping system.

3.3 CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim excess materials as required.

C. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

END OF SECTION 15030

SECTION 15035 - CLOSEOUT

PART 1 - GENERAL

1.1 GENERAL

A. See Division 1, General Requirements.

B. Provide all documentation prior to request for final payment.

PART 2 - PRODUCTS – Not applicable

PART 3 - EXECUTION

3.1 SUBSTANTIAL COMPLETION

A. Review list items corrected, completed or modified to meet project requirements. Provide written summary of the action response to each item. If all items listed are not addressed within thirty (30) working days of issue of Substantial completion punch list the project shall be considered not complete and shall be subject to Liquidated Damages.

3.2 OPERATING INSTUCTIONS

A. Provide instruction as to function, operation, maintenance and adjustment of each equipment item and system provided. Instructional period shall be scheduled with the Owner and arranged to include all personnel designated by the Owner. Notify the Engineer when the instruction period is scheduled.

B. Contractor shall provide Agenda prior to scheduling instructional session with the Owner.

3.3 BROCHURE OF EQUIPMENT

A. Upon completion of work, prepare two (2) copies of Brochure of Equipment containing data pertinent to equipment and systems on job, in one or more three-ring-binders sufficient to hold all literature. Binders shall contain the following sections filed under separate headings:
   1. Warranty: Provide letter of Warranty for mechanical system on Mechanical Contractor's letterhead and signed by authorized representative of Mechanical Contractor.
   2. Suppliers: Provide list of subcontractors and equipment suppliers. List to be complete including address, phone number and contact person.
   3. Parts List: Provide complete parts list for all devices and equipment components. Identify by manufacturer's name and part number, and list names and addresses of suppliers of replacement parts.
   4. Copies of Submittals: Provide copies of each submittal filed under divider heading according to specification section.
   5. Installation, Maintenance, and Operating Instructions: Provide wiring diagrams, Installation, Maintenance and Operating Instructions for each piece of equipment.
   6. Start-up Reports: Provide start-up reports on manufacturer-supplied forms. Forms shall indicate start-up technicians and their qualifications.
   7. Balance Reports: Tabulate Air system balance reports on standard AABC or SMACNA forms.
   8. Temperature Control Drawings: Provide updated shop drawings showing all engineering changes and field modifications. All setpoints determined by Test and Balance, or by coordination with Owner or Engineer, shall be recorded. Include copies of Test and Balance check lists and duct ressure test results.

3.4 OWNER'S RECORD DRAWINGS

A. Submit prints clearly marked with the changes recorded on the "Record Drawings" defined in Section 15010, 3.5, for review by the Engineer. These drawings, when accepted as complete, will be delivered to the Owner by the Engineer as "As-Built Record Drawings".

END OF SECTION 15035

SECTION 15060 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Mechanical supports for piping systems.

PART 2 - PRODUCTS

2.1 HANGERS

A. Bare Pipe:
   1. Copper: Adjustable swivel ring, copper plated steel, ½" to 4", similar to Grinnell Fig. CT-69.
   2. Black Steel: Adjustable swivel ring, zinc plated carbon steel, ½" to 8", similar to Grinnell Fig. 69.
   3. Plastic: Adjustable swivel ring, zinc plated carbon steel, ½" to 8", similar to Grinnell Fig. 69.

B. Insulated Pipe: Adjustable Clevis, black carbon steel, sized for outside diameter of insulation, 2" to 30", similar to Grinnell Fig. 260, with insulation protection shield, galvanized carbon steel, similar to Grinnell Fig. 167.

C. Floor Supports: Riser clamps, black carbon steel, ¾" to 20", similar to Grinnell Fig. 261.

D. Wall Bracketed Pipes: Unistrut, or equivalent, channels anchored to wall with clamps on each pipe. Clamps for insulated pipes shall be sized for the pipe and insulation.

E. Multiple Pipes: Unistrut, or equivalent, channels suspended with threaded rod may be used in lieu of individual hangers to support multiple parallel pipes with clamps on each pipe. Clamps for insulated pipes shall be sized for the pipe and insulation, with insulation protection shields, galvanized carbon steel, similar to Grinnell Fig. 167.

2.2 SLEEVES

A. Steel in concrete and block.

B. PVC below concrete floors.

2.3 PIPE STANDS

A. Steel pipe, no less than 2 sizes smaller than pipe to be supported, with square steel base plate, similar to B-Line figure B3088, with steel pipe saddle support, similar to B-Line Figure 3095.

B. Saddles for pipe sized for both pipe and insulation, with insulation protection shield, galvanized carbon steel, similar to B-Line B3154.

2.4 PIPE CLAMPS

A. Unistrut or equal sized for both pipe and insulated pipe isolator.

PART 3 - EXECUTION

3.1 HANGERS

A. Provide hangers for all piping as specified. Straps are not acceptable. Support pipe horizontally as follows:
   1. Copper (Domestic, Heat Pump Water): 6'-0" O.C. 1 ½" and smaller; and 10'-0" O.C. 2" and larger.
   2. PVC & CPVC Plastic (All Services): 4'-0" O.C. all sizes.
   3. Steel Pipe Screwed (Water): 10'-0" O.C. ¾" and smaller and 12'-0" O.C. 1" and larger.
   4. Steel Pipe Welded (Water): 12'-0" O.C.
   5. Steel Pipe Mechanically Coupled: spacing as recommended by system manufacturer, minimum one hanger on each horizontal pipe section in addition to spacing required by service.

B. Provide inserts in structures as necessary for support of piping.

3.2 SUPPORTS

A. Provide supports for all piping as specified. Straps are not acceptable. Support pipe vertically as follows:
   1. Copper (Domestic, Heat Pump Water): At each floor (not to exceed 10 ft. spacing).
   2. Provide expansion every 30 ft.
   3. Steel pipe screwed (Water): Every other floor (not to exceed 25 ft. spacing).
   4. Steel pipe welded (Water): every other floor (not to exceed 25 ft. spacing).
   5. Mechanically coupled steel pipe: to be supported as recommended by manufacturer.

3.3 SLEEVES

A. Sleeves for pipe shall be sized for both pipe and insulation except for pipes penetrating fire rated construction and exposed pipe through floor to radiation units. Sleeves shall be routed through and tack welded to steel floor deck, preset in concrete walls and floors and grouted in block walls.

3.4 PIPE STANDS

A. Set pipe stand straight and plumb. Arrange for level and flat bearing for base plate, grout as required. Cut pipe to length for firm support of piping without springing pipe fittings.

3.5 PIPE CLAMPS

A. Pipes shall be supported outside the pipe insulation on inserts and metal saddles for free movement of pipe lengths.

END OF SECTION 15060

SECTION 15075 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Identify piping systems, valves and equipment as specified in this section.

1.2 CODES AND STANDARDS

A. Legend, color coding, flow direction arrows and visibility in accord with ANSI A13.1-1981, except pre-existing facility standard color coding shall be used where preferred by Owner.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Product of Seton – “Snap-Around.” Equivalent Champion America, WH Brady Corp., or Ready Made acceptable. Snap-on precoiled printed plastic sheets, protective legend overcoat, ultraviolet inhibitors, for indoor and outdoor use.

2.2 EQUIPMENT

A. Product of Seton. Equivalent Champion America, WH Brady Corp., or Ready Made acceptable.

B. 2 ½”x3/4” aluminum name plates with a black enamel background; with etched or engraved natural aluminum lettering. Phenolic plates with engraved contrasting letters are acceptable.

PART 3 - EXECUTION

3.1 PIPE MARKERS

A. Identify piping systems as follows:

Ground Water Supply (GWS)	Domestic Cold Water (DC)
Ground Water Return (GWR)	Domestic Hot Water (DH)
Domestic Recirc Water (DHR)	Heating Water Supply (HWS)
Heating Water Return (HWR)	

B. All piping shall be identified on 20’-0” centers; except Boiler and Mechanical Room piping shall be identified on 10’-0” centers; and all sections of pipe between flow division valves and/or fittings shall be uniquely identified regardless of length.

C. Provide a printed color-coding schedule encased, framed and mounted near Mechanical Room door.

3.2 EQUIPMENT

A. Nameplate shall be provided for each piece of mechanical equipment such as exhaust fans, etc.; also, for each starter, switch, relay transformer, etc., that controls that equipment. Nameplates shall be securely fastened to all equipment.

B. Verify equipment numbering and nomenclature with Owner for continuation of present system.

3.3 PAINTING

A. All exposed ferrous piping, flanges, unions, valves, supports, etc., shall be painted with one coat of metal primer and one coat of heat resistant black enamel paint.

END OF SECTION 15037

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division -1 Specifications sections, apply to work of this section. ACTION SUBMITTALS

1.3 QUALITY ASSURANCE

A. Contractor's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jacket, coverings, sealers, mastics and adhesives) with a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

C. Paper laminate jackets shall be permanently fire and smoke resistant, unaffected by water or humidity.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation.

B. Schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

C. Manufacturer's recommended installation method.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Fiberglass
1. Product of Johns Manville listed. Equivalent CertainTeed, Knauf, and Fiberglas acceptable.
2. MICRO-LOK glass fiber insulation: long, flame attenuated glass fibers bonded with a thermosetting resin. One-piece “hinged” construction for easy installation.
3. Jacketing: AP-T Plus all-purpose jacket of white kraft bonded to aluminum foil and reinforced with fiberglass yarn. Longitudinal lap of pressure sensitive tape.
4. Fittings: Zeston 25/50 premolded one-piece PVC insulated fitting covers.

Fluid Design Operating Temperature Range °F	Insulation Conductivity Range	Fluid Type	Run-outs up to 2"	1" and Less	1-1/2 to 2"	2-1/2 to 4"	5 & 6"	8" and Up
105°F & Up	0.24-0.28	Domestic Hot, Heat Pump	0.5	1.0	1.0	1.5	1.5	
	0.24-0.28	Dom. Cold	0.5	1.0	1.0	1.0	1.0	

5. Thickness as scheduled, except ½" thick within interior walls and through header plates, only where space is limited and does not permit scheduled thickness.
Zeston 2000 PVC cut and curled jacketing, 15 ml thickness, UL 25/50 rating, immune to galvanic or electrolytic corrosion.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Contractor or Architect/Engineer.

B. All piping shall be pressure tested prior to insulation.

C. All ductwork shall be properly sealed and/or leak tested prior to insulation.

3.2 PIPING INSULATION

A. Plumbing System Application Requirements:
1. Insulate the following cold plumbing piping systems:
a. All domestic cold-water piping.
2. Insulate the following hot plumbing piping systems:
a. All domestic hot water piping.
b. All domestic hot water recirculating piping.
c. All boosted domestic hot water piping, temp >130°F (thickness same as heating water piping for operating temperature.)
3. Exceptions: Insulation is not required on:
a. Chrome-plated fixture supply piping.
b. Air chambers.
c. Unions.

d. Strainers.
e. Check valves.
f. Balancing valves.
g. Drain valves from water coolers.
h. Storm drain piping located in crawlspaces or tunnels.
i. Buried piping.
j. Fire protection piping.
k. Pre-insulated piping in equipment.

3.3 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: Insulation on **hot** piping within radiation enclosures; and unions on hot piping; flanges on hot piping; strainers on hot piping; balancing valves on hot piping; and flexible connections on hot piping.

B. Hot Low-Pressure Piping:
1. Application Requirements: Insulate the following hot low-pressure HVAC piping systems.
   a. All HVAC hot water supply and return piping.
   b. Patch and repair all existing piping insulation found within construction area.
2. Insulate each piping system specified above with the type and thickness of insulation listed above.
3. Wrap all piping located within small equipment cabinets to prevent condensation dripping.

C. Chilled Water Piping:
1. Application Requirements: Insulate the following low-pressure cold HVAC piping system.
   a. All interior chilled water supply and return piping.
   b. Re-insulate all accessible chilled water piping in work area.
   c. Re-insulate exterior chilled water supply and return piping above grade.
   d. All chilled water piping fittings shall be insulated to prevent condensation.
   e. Piping and fittings located within small equipment cabinets, which cannot be insulated with linear warp or standard fittings, shall be wrapped with insulation tape.

D. Jacketing and Coating Application Requirements
1. Protect the following piping systems as indicated:
   a. Existing exterior chilled water supply and return on roof – metal jacketing.

3.4 INSTALLATION OF PIPING AND EQUIPMENT INSULATION

A. General: Install insulation products in accordance with manufacturer's written instruction, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete runs. DO NOT use cut pieces or scraps abutting each other.

C. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier jackets on pipe insulation and protect from puncture or other damage.

E. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units.

F. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

G. Butt insulation against pipe hanger insulation inserts. For hot pipe, apply 3 “wide vapor barrier tape or band over butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3 “wide vapor barrier tape or band.

H. Piping exposed to weather: Protect outdoor insulation from weather by installation of weather-barrier jacketing, as recommended by the manufacturer.

I. Apply piping cement to terminate ends of all insulation.

J. Tape insulation should be applied with a spiral wrap to obtain a 50% overlap. To insulate valves, tees and other fittings, small pieces of tape should be cut to size and pressed into place, with no metal exposed. The fitting then is additionally over-wrapped with longer lengths for a durable finish.

K. Jacket all insulation exterior to the building whether located within equipment pipe chase or not.

L. Hanger inserts shall be installed under the pipe at hangers external to the insulation; at unistrut clamps; and at trapeze supports. Thickness to be equal to the adjoining insulation with vapor barrier seals for cold surfaces.

3.5 INSTALLATION OF PIPING AND EQUIPMENT INSULATION

A. General: Install insulation products in accordance with manufacturer’s written instruction, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete runs. DO NOT use cut pieces or scraps abutting each other.

C. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier jackets on pipe insulation and protect from puncture or other damage.

E. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units.

F. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Heating piping insulation should extend to individual unit isolation valves or within 2' of coil whichever is closest. Chilled water piping shall be extended through unit accessories to coil connections.

G. Butt insulation against pipe hanger insulation inserts. For hot pipe, apply 3 “wide vapor barrier tape or band over butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3 “wide vapor barrier tape or band.

H. Piping exposed to weather: Protect outdoor insulation from weather by installation of weather-barrier jacketing as recommended by the manufacturer. Fiberglass insulation is NOT PERMITTED where exposed to Weather.

I. Apply piping cement to terminate ends of all insulation.

J. Tape insulation should be applied with a spiral wrap to obtain a 50% overlap. To insulate valves, tees and other fittings, small pieces of tape should be cut to size and pressed into place, with no metal exposed. The fitting then is additionally over-wrapped with longer lengths for a durable finish.

K. Jacketing: Childers aluminum jacketing secured with sheet metal screws in overlapping longitudinal seams and joints. Lap joints for optimum water shedding. Cut fiberglass pipe insulation to shape in order to fill voids inside fitting covers.

L. Ground Source water shall be treated as a chilled water system with average loop temperature 40°F or below. Provide condensation spray at all exposed fittings and connections.

END OF SECTION 15080

SECTION 15100 - PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Heat Pump Pipe and Fittings.
   2. Drain Pipe and Fittings.

B. Related Sections:
   1. 15060 Hangers and Supports.
   2. 15080 Mechanical Insulation.

1.2 REFERENCE

A. American National Standards Institute (ANS)

B. American Society for Testing and Materials (ASTM)

C. American Water Works Association (AWWA)

D. International Association of Plumbing & Mechanical Officials (IAPMO)

E. National Sanitation Foundation (NSF)

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPE

A. Interior Service: Copper, Type "L" hard, conforming to ASTM B-88 with wrought or cast solder fittings for above grade conforming to ANSI B16.22.

2.2 HEAT PUMP PIPE

A. Copper: Type “L” hard, conforming to ASTM B-88.
   1. Wrought copper or cast brass solder fittings conforming to ANSI B16.22.
   2. Wrought copper or cast brass “press-fit” fittings for above grade conforming to ANSI B16.22.
   3. Wrought copper or cast brass grooved fittings for mechanical joints conforming to ANSI B16.22 and ANSI B16.18 with copper tubing sized grooved ends, EPDM gaskets for temperatures to 230°F and working pressure to 150 PSI.
      a. Rigid couplings; 2" to 8"; angled pad design for rigidity.
      b. Rigid couplings; 2" to 8"; installation ready stab-on design for installation without prior field disassembly, and no loose parts; housings cast with offsetting angle-pattern bolt pads.

B. Steel: Standard weight, Schedule 40 conforming to ASTM A-53.
   1. Cast iron screwed fittings 2" diameter and smaller, and malleable iron welding fittings 2½" diameter and larger. Provide flange fittings at valves, pumps and equipment. No threadolets, weldolets or welded stubs for branches off mains.
   2. Rolled groove ends; ductile iron rolled groove fittings; mechanical couplings, mechanical side outlet couplings, and hole cut branch tap fittings; with EPDM gaskets for

temperatures to 230°F and working pressure to 150 PSI. Provide flange fittings at valves, pumps, and equipment.

C. Relief Vent: Steel, standard weight, Schedule 40 conforming to ASTM A-53; malleable iron fittings conforming to ASME B16.3.

2.3 DRAIN PIPE

A. Cooling Coil Condensate:
1. Schedule 40 PVC with solvent weld joints.
2. Copper type “L” hard with wrought copper or cast brass solder fittings.

B. Backflow Preventer Relief Ports:
1. Schedule 40 PVC with solvent weld joints.
2. Copper type “L” hard with wrought copper or cast brass solder fittings.

C. Pressure/Temperature Relief Valve Discharge
1. Copper type “L” hard with wrought copper or cast brass solder fittings.

PART 3 - EXECUTION

3.1 DOMESTIC WATER PIPE

A. Pitch for proper air relief and drainage: 1' per 25'. Provide valves at low points to drain system.

B. Escutcheons chrome plated at all pipes through walls, floors, or ceilings of finished spaces, including under cabinets.

C. Anchor pipe securely to building structure in both directions where indicated and/or required.

D. Relief valve discharge piped to floor, cut on the diagonal, and anchor.

E. Shut-off valves in supplies serving each bank of fixtures where indicated and/or required.

F. Copper joints reamed, polished and joined with lead free solder that meets ASTM B-32. No self-cleaning flux permitted. Flux shall meet ASTM BA13. No joints below concrete slab when using copper water piping.

G. Threaded joints shall be joined with lead-free pipe dope.

H. Test lines to 125 PSI hydrostatic with no visual leaks or abnormal pressure loss. Provide a certificate of acceptance, signed by the Owner's Representative, to be incorporated in the Operation and Maintenance Manual.

3.2 HEAT PUMP WATER PIPE

A. Provide for movement due to expansion. Anchor pipes securely when required for distributing expansion stresses. Swing joints at all supply and return take offs from main lines.

B. Measure and cut to actual building conditions, install parallel and perpendicular to walls, beams, etc. Install without forcing or springing riser plumb.

C. Clearance from other pipe or obstacles and within sleeves adequate to permit insulation and maintenance.

D. Pitch: Water piping up 1" per 40' in direction of flow; Down feed branches off bottom side of main, pitched down ½" per foot; Up feed branches off top side of main, pitched up ½" per foot. Drain valves at low points to drain system.

E. Valves and piping installed adjacent to pumps, heat pumps, etc., same as line size unless sized for pressure drop.

F. Copper solder fittings: Piping reamed, polished and joined with 95-5 lead-tin solder. No self-cleaning flux.

G. Copper “press-fit” fittings: Piping square cut, deburred and cleaned. Fitting manufacturer’s gauge used to ensure full insertion into the coupling or fitting. Fitting manufacturer’s tool used for pressing.

H. Threaded fittings: Full, clean threads. Joints made with an approved oil-graphite compound applied to male thread.

I. Solvent weld fittings: Piping square cut, deburred, cleaned and marked for full insertion into couplings or fittings. Joint compound applied to pipe and fitting prior to insertion in accordance with manufacturer’s directions.

J. Test line to 100 PSI hydrostatic with no visual leaks or abnormal pressure loss. Provide a certificate of acceptance, signed by the Owner's Representative, to be incorporated in the Operation and Maintenance Manual.

3.3 DRAIN PIPE

A. Slope down ¼" per foot, route to floor drain and anchor.

B. Trap of 3" water seal depth minimum with vent.

END OF SECTION 15100

SECTION 15110 - MANUAL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Inline valves for manual shut-off, service isolation, basic flow control and drainage.

PART 2 - PRODUCTS

2.1 WATER SERVICE

A. Manufacturer: As scheduled. Equivalent Apollo, Boss, Crane, Grinnell, Jenkins, Hammond, Legend, McDonald, Milwaukee, Nibco, Stockman, Walworth, Worcester acceptable. All valves of each type of one manufacture, with manufacturer's identification tag on handle.

B. Requirements:

1. Ball Valves: Valves shall be rated 150 psi SWP and 600 psi non-shock WOG. Construction: Two-piece cast bronze body, TFE seats, separate packnut with adjustable stem packing, anti-blowout stems and stainless-steel balls. The valves to be manufactured to MSS-SP110 standards. Provide 2" extended non-thermal conductive handles for all insulated valves.
   Full port valves through 1" and conventional port 1-1/4" and larger. Sizes ½" –3".
2. Globe Valves: Valves shall be Class 150 union bonnet. Manufactured in accordance with MSS-SP80. Construction: Bronze body and bonnet equal to ASTM B-62. Stems shall be dezincification- resistant silicone bronze ASTM B-371 or low zinc alloy B-99, non-asbestos packing TFE seat disc and malleable or ductile iron handwheel.
3. Check Valves: Valves shall be Class 125.
   a. Size 2-1/2" or Smaller
      Construction: ASTM B-62 bronze body with TFE seat disc.
      Y-pattern swing type manufactured in accordance with MSS-SP80.
   b. Size 3" and Larger.
      Swing type manufactured in accordance with MSS-SP71.
      Valve Construction: Flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket or wafer style with stainless steel spring, bronze disc plates, rubber seat, body of ASTM A 126 Class B.
   c. Lift Checks.
      Spring-actuated for immediate closure.
      Valve Construction: Cast iron ASTM-A126 body, bronze seat and disc ASTM B584, Type 316 stainless steel spring, stop pin and hinge.
4. Drain Valves: Valves to be rated to 200 psig non-shock cold water working pressure. Construction: Forged brass body, aluminum handle, coated steel handle nut and Teflon seat. Ball design with ¾" hose end. Provide service cap for hose end.

C. Domestic/Heat Pump Water

Valve	*Mfg.*	*½" - 2"*	*2½" - 3"*	*4" - 12"*
Ball	Nibco	580-70-66	580-70-66	--
Globe	Nibco	--	F718-B	F718-B
Check	Nibco	433-Y	433-Y	W920-W F-918-B
Drain	Legend	107-168	--	--

2.2 DOMESTIC WATER BALANCING VALVES

A. For Balancing and Measuring Valves:
   1. Product of Taco. Equivalent Armstrong, and Bell and Gossett.
   2. Model Accu-Flo, circuit setter. The valve shall be a combination service shut-off, balancing and flow measurement device. The materials of construction shall be blow-out proof, sealed with an EPDM O-ring. The flow measurement shall be accomplished by means of a fixed geometry venture style sensor of corrosion resistant materials. Pressure reading ports shall be Schrader style connection. The valve shall be a double seated ball style, and the seat shall be Teflon and designed for shut-off service. The memory stop shall be robust design capable of flowing return of the stem/ball to originally set position after use as a servicing shut-off valve. The balancing valve stem shall have wrenching flats for normal setting. The valve stem all be capable of operation by a 4:1 turn ratio for stem positioning. The valve may have a plugged drain connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Application: Ball, gate and butterfly valves for use as shut-off; globe and butterfly for throttling duty.
   1. Locate all valves for maximum service access to handle for operation and that the valve in turn can be removed for servicing without removing any other piping or equipment.
   2. Locate all valves to allow valve position indication to be read while standing at floor level.
   3. Install valves in horizontal piping with stem at or above the center of the pipe.
   4. Install valves in position to allow full stem movement.
   5. Tests: After piping systems have been tested and put into service, inspect valves for leaks prior to final balancing. Adjust or replace packing if required. If leaks persist replace the valve prior to final balancing.

3.2 REMOVAL PROVISIONS

A. Install screwed and soldered valves with union connections at one end for equipment removal. Flanged devices do not require removal provisions.

3.3 DIELECTRIC PROVISIONS

A. Provide dielectric unions or dielectric gaskets for all valves and piping of dissimilar materials.

3.4 THREADED CONNECTIONS

A. Apply appropriate tape and or thread compound to the mail pipe threads.

END OF SECTION 15110

SECTION 15115 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Pressure Reducing Stations.
   2. Backflow Preventers.

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature, installation instructions and maintenance requirements.

PART 2 - PRODUCTS

2.1 PRESSURE REDUCING STATION

A. Product of Watts. Equivalent Fisher acceptable. Model 223, size ½" - 1½", 75 PSI in, 12 PSI out. Bronze body, stainless steel components, complete with strainer and unions.

PART 3 - EXECUTION

3.1 PRESSURE REDUCING STATION

A. Adjust PRV for satisfactory system pressure at design flow.

3.2 BACKFLOW PREVENTERS

3.3 GENERAL

A. All valves shall be located for maximum service access for operation and maintenance.

3.4 CONTROL VALVE INSTALLATION

A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

B. All control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position.

C. Valves shall be installed in accordance with the manufacturer's recommendations.

D. Control valves shall be installed so that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.

E. Isolation valves shall be installed such that control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screwed type control valves.

F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1-1/2" in diameter, with 1/4" high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

END OF SECTION 15115

SECTION 15120 - PIPE SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Unions and Reducers.
   2. Escutcheons.
   3. Strainers.
   4. Thermometers.
   5. Gauges.

B. Related Section: 15100 – Pipe and Fittings

PART 2 - PRODUCTS

2.1 UNIONS AND REDUCERS

A. Unions and reducers as required having the same gauge and material as the pipe.

B. Dielectric Unions: Rated at 250 psig at 180°F conforming to ANSI B16.39. Factory certified to withstand a minimum of 600 volts on a dry line with no flash over. All pipe threads are in accordance with ANSI B2.1.

2.2 ESCUTCHEONS

A. Split ring, chrome plated, concealed hinges, tension clamp.

B. Sure grip flanges, chrome plated, shallow, deep or box type as required.

2.3 STRAINERS

A. Product of Sarco or equal. Construction: Cast bronze body ASTM B62 with external rib, tapered screen socket, stainless steel 1.045 perforated screen, blow-down plug and sediment collection chamber below screen. Sizes ½” to 3”. For sizes 4” and larger use Sarco model AF-250 flanged strainer or equal

2.4 THERMOMETERS

A. Product of Trerice. Equivalents acceptable. Model BX, adjustable mount, 9" enclosed window case, with range as follows:
   1. Domestic hot water 30°F to 240°F
   2. Heat Pumpwater 30°F to 100°F

2.5 GAUGES

A. Pressure: Product of Trerice. Equivalents acceptable. Model 800 brass gauges, 2½" dial, with range as follows: Heating water 0 to 60 PSI

PART 3 - EXECUTION

3.1 UNIONS AND REDUCERS

A. Install unions where shown on the drawings and where required for proper maintenance to remove equipment, valves, pipe sections, etc. Unions must be installed only in accessible locations.

3.2 ESCUTCHEONS

A. Install escutcheons in all finished areas including under cabinets. Use deep flange type to conceal PVC to metal coupling nuts and piping sleeves through walls.

3.3 STRAINERS

A. Install all fittings with union connections at one end for equipment removal. Flanged units do not require unions. Provide blow-down valve for all units 2” and larger. Pipe blow down to nearest floor drain.

3.4 THERMOMETERS

A. Provide wells in tanks and piping. Install at height and angle for viewing from a standing position on the floor.

3.5 GAUGES

A. Pressure: Provide gauge tees in piping. Install shut-off valves and siphon tubes in gauge lines.

3.6 GENERAL

A. Mount all specialties for adequate access and removal room.

END OF SECTION 15120

SECTION 15740 – MULTISTACK WATER TO WATER HEAT PUMP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes design, performance criteria, refrigerants, controls, and installation requirements for Multistack air cooled centrifugal chillers.

1.2 REFERENCES

A. Comply with the following codes and standards: (as adopted by each individual State)
   1. ARI 550/590
   2. ANSI/ASHRAE 15
   3. ASME Section VIII
   4. NEC
   5. ETL
   6. CSA
   7. OSHA

1.3 SUBMITTALS

A. Submittals shall include the following:
   1. Unit dimensional drawings with elevation overview. Drawings to include required service clearances, location of all field installed piping and electrical connections.
   2. A summary of all auxiliary utility requirements for normal system operation required. Auxiliary utility requirements include: electrical, water, and air. Summary of auxiliary equipment shall include quantity and quality of each specific auxiliary utility required.
   3. Control documentation to include: Control hardware layout, wiring diagrams depicting factory installed wiring, field installed wiring with points of connection, and points of connection for BAS control/interface points.
   4. Sequence of operation depicting overview of control logic used.
   5. Installation and Operating Manuals.
   6. Manufacturer certified performance data at full load in addition to either IPLV or NPLV.

1.4 DELIVERY AND HANDLING

A. Unit(s) shall be delivered to the job site completely assembled and charged with complete refrigerant charge.

B. Installing contractor to comply with the manufacturer’s instructions for transporting, rigging and assembly of unit.

1.5 WARRANTY AND START-UP

A. Manufacturer shall provide full parts-only warranty coverage for entire unit for a period of one year. All parts shall be warranted against defects in material and workmanship. Similar part-labor coverage shall be provided for the unit’s compressors for a period of five years. The warranty period shall commence either on the equipment star-up date or six months after shipment, whichever is earlier.

B. Manufacturer shall provide the services of a Factory Authorized Service Engineer to provide complete start-up supervision. After start-up a Manufacturer’s Representative shall provide a minimum of 2-hours of operator training to the Owner’s designated representative(s).

PART 2 - PRODUCTS

2.1 OPERATING CONDITIONS

A. Provide water-to-water heat pump with the capacity as scheduled on drawing at job site elevation listed at 2400 ft.

B. Heat Pump shall be designed to operate using R-410a refrigerant.

C. Heat Pump shall be designed for parallel evaporator water flow.

D. The liquid to be heated and cooled will be water containing corrosion inhibitors.

E. Heat Pump shall be designed to operating using 208 volt, 3 phase, 60 Hz electrical power supply.

2.2 WATER-TO-WATER PACKAGED HEAT PUMP

A. Approved manufacturer is MULTISTACK. Equivalent approved upon request

B. System Description: Heat Pump shall incorporate Scroll-type compressors. Each refrigerant circuit shall consist of an individual compressor, common dual circuited condenser, dual circuited evaporator, electronic expansion valve (thermal expansion valve not acceptable), reversing valve, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit heat pump must be able to produce shilled water even in the event of a failure of one or more refrigerant circuits. Circuits shall not contain more than 6.5 lbs. of R-410a refrigerant.

C. General
1. Heat Pump Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.
2. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on and AHRI certified or 3rd party verified test stand.
3. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge, powder coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.

D. Water Mains: Each module shall include supply and return mains for both load and source-sink water. Cut grooved end connections are provided for interconnection to six-inch standard (6.625” outside diameter) piping with grooved type couplings. Rolled grooved shall be unacceptable. Water Mains shall be installed such that they are beneath any power or control wiring so as to insure for safe operation in the event of condensation or minor piping leaks.

E. Heat Exchangers: Each load and source-sink heat exchanger shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig refrigerant side working pressure and 360 psig water side working pressure. Heat exchangers shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

F. Compressor: Each module shall contain two hermetic scroll compressors independently circuited and mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.

G. Central Control System

1. Scheduling of the various compressors shall be performed by a microprocessor-based control system (Master Controller.) A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
2. The Master Controller shall monitor and report the following on each refrigeration system:
    a. Discharge Pressure Fault
    b. Suction Pressure Fault
    c. Compressor Winding Temperature
    d. Suction Temperature
    e. Load Leaving Water Temp
    f. Source-Sink Leaving Water Temp
3. The Master Controller shall be powered by the units single point power connection and shall monitor and report the following system parameters:
    a. Load Water Entering and leaving Temperature
    b. Source-Sink Water Entering and Leaving Temperature
    c. Load Water and Source-Sink Water Flow
4. An out of tolerance indication from these controls or sensors shall cause a “fault” indication at the Master controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire heat pump will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master controller’s 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences.)
5. Individual monitoring of leaving water temperatures from each refrigeration system shall be programmed to protect against heat exchanger freeze-up.
6. The control system shall monitor entering and leaving water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the heat pump performance to different existing building loads.
7. The heat pump mode (heating and cooling) shall be selected by an external dry contact interlock to the Master Controller. If no interlock is present or in the event of a reversing valve solenoid failure, the system shall revert to heating mode.

H. Heat pump shall have a single point power connection and external inputs and outputs to be compatible with the building management system. Inputs/Outputs include:
1. Remote Start/Stop
2. Cooling Alarm

I. Each inlet water header shall incorporate a built in 30-mesh (maximum) in-line strainer system to prevent heat exchanger fouling and accommodate 100% flow filtration with a minimum surface area of 475 sq inches per module.

J. Single Point Power**:** Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power rated at 5,000-amp SCCR. Where the equipment sized exceeds the amp rating of the buss bar, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.

2.3 SAFETIES, CONTROLS AND OPERATION

A. Heat pump safety controls system shall be provided with the unit (minimum) as follows:
1. Low refrigerant pressure
2. Loss of flow through the source/sink heat exchanger

3. Loss of flow through the load heat exchanger
4. High refrigerant pressure
5. High compressor motor temperature
6. Low suction gas temperature
7. Low leaving water temperature

B. Failure to heat pump to start or heat pump shutdown due to any of the above safety cutouts shall be annunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

C. The heat pump shall be furnished with a Master Controller as an integral portion of the heat pump control circuitry to provide the following functions:
1. Provide automatic heat pump shutdown during periods of when the load level decreases below the normal operating requirements of the heat pump. Upon an increase in load, the heat pump shall automatically restart.
2. Provisions for connection to automatically enable the heat pump from the remote energy management system.
3. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.

D. Normal Heat Pump Operation
1. When heat pump is enabled, the factory supplies Master Controller modulates the heat pump capacity from minimum to maximum as required by building load.
2. The heat pump control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.
3. The operating mode (heating and cooling) shall be determined by a customer provided dry contact interlock.

E. Power Phase Monitor (PPM)
1. Provide a Power Phase Monitor on the incoming power supply to the heat pump. This device shall prevent the heat pump from operating during periods when the incoming power is unsuitable for proper operation.
2. The Power Phase Monitor shall provide protection against the following conditions:
a. Low Voltage (Brown-Out)
b. Phase Rotation
c. Loss of Phase
d. Phase Imbalance

PART 3 - INSTALLATION

3.1 PIPING SYSTEM FLUSHING PROCEDURE

A. Prior to connecting the heat pump to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organics. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

B. During the flushing, a 30 mesh (max) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of the board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean.

Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

C. Prior to supplying water to the heat pump the Water Treatment Specification shall be consulted for requirements regarding the water quality during heat pump operation. The appropriate heat pump manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.2 WATER TREATMENT REQUIREMENTS

A. Supply water for both the Loop water and source water circuits shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the heat pump's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular heat pumps using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters:

1.	pH	Greater than 7 and less than 9
2.	Total Dissolved Solids (TDS)	Less than 1000 ppm
3.	Hardness as $CaCO_3$	30 to 500 ppm
4.	Alkalinity as $CaCO_3$	30 to 500 ppm
5.	Chlorides	Less than 200 ppm
6.	Sulfates	Less than 200 ppm

END OF SECTION 15740

SECTION 15940 - MECHANICAL OPERATING SEQUENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all engineering, labor, materials and service necessary to provide system operation as described in this section.

PART 2 - PRODUCTS

2.1 REFERENCE

A. Applicable systems, equipment and products are specified in Section 15900.

PART 3 - EXECUTION

3.1 HEATING SOURCE

A. Water to Water Heat Pump
   1. General
      a. Unit mounted controls to maintain tank temperature at heating water reset schedule.
         1) Tank temperature 120°F when OAT is below 10°F
         2) Tank Temperature 80°F when OAT is 60°.
      b. Unit controls are locked out when OAT is above 65°F (adjustable) (Warm Weather Shutdown Temperature.
      c. Extend unit outside air sensor to building exterior to allow unit mounted control operation.
      d. Provide tank sensor to cycle unit as required to maintain tank temperature.
   2. Heat Pump Operation
      a. Unit released for operation when OAT is below Warm Weather Shut-down temperature.

B. Heat Pump Circulation Pumps
   1. Source Pump (CP-Source) to operate continually during unit operation.
   2. Load Pump (CP-Load) to operate continually during unit operation. AIR HANDLING UNITS

END OF SECTION 15940

SECTION 15950 – TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes TAB to produce design objectives for the following:
   1. Hydronic Piping Systems:
      a. Constant Flow systems.
   2. HVAC equipment quantitative performance settings.
   3. Verification that automatic control devices are functioning properly.
   4. Reporting results of activities and procedures specified in this Section.

1.2 SUBMITTALS

A. Strategies and Procedure Plan: Within 60 days from Contractor's Notice to Proceed, submit (10) copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article.

B. Certified TAB Report: Submit five copies of reports prepared as specified in this Section, on approved forms certified by TAB firm.

1.3 QUALITY ASSURANCE

A. Tab Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Certification of Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in the Specification.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilation and Air Conditioning Systems;" NEBB's "Procedural Standards for Testing Adjusting and Balancing of Environmental Systems;" SMACNA's "HVAC Systems – Testing, Adjusting and Balancing;" or TAB firm's forms submitted for approval prior to commencement of balance.

1.4 COORDINATION

A. Coordinate the efforts of factory-authorized representatives for systems and equipment, installers of HVAC controls, and other mechanics to operate HVAC systems and equipment in order to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on the air and water distribution systems have been satisfactorily completed per the project Engineer.

1.5 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the contract Documents.

1.6 SYSTEM DESCRIPTION

A. System Requirements:
   1. Balance all new and modified air distribution systems.
      a. Provide total equipment performance information for all scheduled equipment.
   2. Balance all new and modified hydronic systems including all individual coils and terminal units.
      a. Provide flow information for all flows indicated on the drawings.
      b. Provide total equipment performance information for all scheduled equipment.
   3. Balance all new domestic recirculation setters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings and manual volume dampers are required by the Contract documents. Verify that qualities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Related performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions and thereby cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems-Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examined system and equipment installations to verify that they are complete, and that testing, cleaning, adjusting and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers are properly installed and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume devices to verify that they are accessible, and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine three-way control valves for proper installation for their intended function of mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:
1. Dampers, valves and other controlled devices are operated by the intended controller.
2. Dampers an valves are in position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and open positions.
4. Thermostats are located to avoid adverse effects of sunlight, drafts and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to indicated values.

R. Examine variable speed drives to verify proper function.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to change conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare TAB plane that includes strategies and step-by-step procedures.

B. Complete readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean and free of air.
3. Automatic temperature control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceiling are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so that indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems;" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems;" or SMACNA's "HVAC Systems – Testing, Adjusting, and Balancing."

B. Cut insulation, ducts, pipes and equipment cabinets to the minimum extent necessary for installation of test probes to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new material identical to those removed. Restore vapor barrier and finish according to insulation Specifications for the Project. See Section 15100.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper control positions, valve position indicators, fan-speed-control levers and similar controls and devices to show final settings.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems “As-Built” piping layouts.

C. Prepare hydronics for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check make-up water station pressure gauge for adequate pressure for highest vent.
4. Set differential pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive displacement type unless several terminal valves are kept open.
5. Set system controls so automatic valves are wide open to heat exchangers.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump motor load. If motor is overloaded, throttle main flow-balancing devices so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
9. Place all units in full cooling as necessary to verify variable flow conditions.

3.5 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive displacement pumps.
1. Verify impeller size by operating the pump within the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gauge heights. Note the point on manufacturer’s pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer’s head capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-moto horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer’s performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated pre-settings.

C. Measure flow stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow indicating device.

D. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow indicating device.

3.6 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply return and exhaust fans and equipment with fans: Plus 4 to plus 10 percent.
   2. Air outlets and inlets: 0 to minus 10 percent.
   3. Heating water flow rate: 0 to minus 10 percent.

3.7 FINAL REPORT

A. General: Typewritten, or computer printout in letter quality font, on standard bond paper, in three ring binder, tabulated and divided into section by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures along with proof of calibration.

C. Final Report Comments: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturer test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title Page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect’s name and address.
   6. Engineer’s name and address.
   7. Contractor’s name and address.
   8. Report data.
   9. Signature of TAB firm certifying the report.
   10. Table of contents with the total number of pages defined for each section of the report. Number each page of the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer, type size and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Setting for outside, return and exhaust air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet and dry bulb conditions.
      d. Face and by-pass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Settings for supply air, static pressure controllers.
      g. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single line diagram and include the following:
   1. Quantities of outside, supply, return and exhaust airflows.
   2. Water flow rates.
   3. Duct, outlet and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.
   6. Balancing stations.
   7. Position of balancing devices.

3.8 ADDITIONAL TESTING

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balance conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 15950